

Study on the Indicators of Driver Fatigue on Prairie Highway Landscape Environment

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Abstract: Combining with Fatigue Scale the research finding show: Driver fatigue can be described by the growth of heart rate and Heart rate variability in prairie highway landscape environment. Heart rate variability is more sensitively than heart rate.

Keywords: Prairie highway landscape environment; Driver fatigue; Growth of Heart Rate; HRV

1 Introduction

Fatigue driving is a factor which can lead to traffic accidents. Many experts ^[1-4] take different methods and experiment to research on it. So far, there is no uniform standard about driver fatigue. And there is a little study on driving fatigues in special typical areas. However, this study

in these areas can contribute to driver fatigue study. So this paper study on the indicators of driver fatigue on prairie highway landscape environment to complete driving fatigue indicators research.

2 Experimental Method

2.1 Experimental section of basic information

Considering the three sections of the traffic flow survey, landscape features, conditions and other factors, our study chooses the secondary roads of provincial highway 101 lines about Saihantala to Mandulatu road segment as the research object. The road sections of the basic information about linear indicators are shown in Table 1.

Table 1 the General statistics about linear indicators of Survey sections

linear index of categories	Saihantala to Mandulatu
length of the longest straight line(m)	8741.3
length of the shortest line(m)	292.64
minimum curve radius (m)	295
maximum Radius (m)	40000
maximum longitudinal slope (%)	-4.924
minimum slope length (m)	172
maximum slope length (m)	2014.7
maximum radius of vertical curve (m)	400000
minimum vertical curve radius (m)	2024.64

2.2 Basic information of laboratory personnel

This experiment adopts stratified random sampling method to select good health, driving experience and no

accidents occurred in the drivers. As the experimental conditions of experimental sections and field sections, financial constraints, this study only selects five driver for

real driving experiments. The basic information of testing driver is shown in Table 2.

Table 2 The basic information of driver

driver num ber	gender	age(years)	driving experience (years)	health	professional	sections of familiar ity
01	male	48	19	good	teacher	unfamiliar
02	male	41	4	good	teacher	unfamiliar
03	male	40	13	good	teachers	unfamiliar
04	male	40	2	good	teachers	unfamiliar
05	female	49	2	good	teachers	unfamiliar

2.3 Experimental Methods

Real driving experiment, the test requires adjacent to the date and selects the same time period of fine weather. It should be less traffic in the test section in order to reduce factors of weather, body rhythm, overtaking, and other non-road environment to affect driver heart rate. To reduce the car factor on driver heart rate, the experiment should be used the same test vehicle.

In the experimental section, the driver drives the car to travel at 80km / h speed (design speed) through the 100km section of grassland test road section. Tester use RM6240B multi-channel physiological signal acquisition and

processing system to collect the driver's physiological signals (ECG, eye signals) for continuous acquisition. 5 experimental groups are obtained valid data, each data record of the experimental subjects the change of driver's biological signals on testing road. During the experiment, the driver and experimental subjects who can not speak, listen to music. Meanwhile tester should record the information about road alignment, landscape, overtaking, being overtaken during the experiment on testing road.

3 Data Analysis

3.1 HR growth rate of 01 to 05 drivers

HR Growth Rate (%)

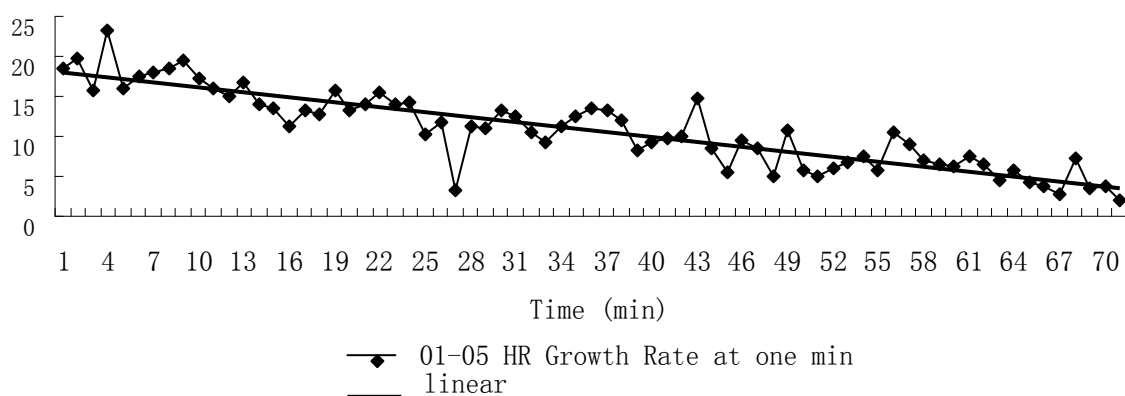


Fig.1 HR growth rate of 01 to 05 drivers on the speed limit road section

From fig.1 we know that the average HR rate of o1 to 05 drivers is decreased with the increase in driving time. At the initial phase of experimental, drivers are not familiar with the environment (road and experimental apparatus) so that the average HR rate of o1 to 05 drivers is about 20%. With

driving time increasing, the average HR rate of o1 to 05 drivers goes down indicates that drivers adjust to the driving environment. In driving time for 25min-30min and 40min-45min, the average HR rate of o1 to 05 drivers appears mutation. Combining of questionnaire show that

80% of drivers appear fatigue at 25min-30min time. In addition, experimental vehicle is through the toll station at 40min-45min time.

3.2 the statistical analysis of drivers' heart rate variability

The each segment is 5 minutes. It includes in the table that

the statistics values of each segment about the SDNN, RMSSD, PNNF50, LFnorm, HFnorm, TP, LF / HF. Values in the table in this section are expressed by mean $\pm$ standard deviation.

Table.3 Drivers' HRV indicators per 5 minutes on the speed limit section

Time (min)	SDNN	RMSSD	PNN50	LFnorm	HFnorm	TP	LF/HF
2-6	77.4 $\pm$ 77.2	73.3 $\pm$ 85.8	0.7 $\pm$ 0.8	61.5 $\pm$ 12.9	16.5 $\pm$ 1.6	53997.4 $\pm$ 80572	4.4 $\pm$ 1.1
7-11	21 $\pm$ 2.2	14.9 $\pm$ 0.3	0.2 $\pm$ 0.3	50.6 $\pm$ 3.3	19.6 $\pm$ 3.6	646.7 $\pm$ 58.1	4.7 $\pm$ 1.2
12-16	27.8 $\pm$ 11.5	22.9 $\pm$ 16.8	0.5 $\pm$ 0.9	45.9 $\pm$ 9.7	20.6 $\pm$ 9.6	1216.8 $\pm$ 930.2	4.2 $\pm$ 2
17-21	22.4 $\pm$ 3.2	15.8 $\pm$ 0.5	0.3 $\pm$ 0.3	38 $\pm$ 19.2	19 $\pm$ 9.1	734.2 $\pm$ 366.3	3.4 $\pm$ 0.4
22-26	26 $\pm$ 2.5	15.7 $\pm$ 1	0.3 $\pm$ 0.3	56.1 $\pm$ 9.3	25.1 $\pm$ 5.4	617.7 $\pm$ 254.1	3.5 $\pm$ 1.1
27-31	108.6 $\pm$ 126	119.3 $\pm$ 170	0.7 $\pm$ 0.8	51.7 $\pm$ 11.4	22.4 $\pm$ 8.2	119178.6 $\pm$ 201752	3.6 $\pm$ 1.6
32-36	55.3 $\pm$ 44.2	63.1 $\pm$ 66.1	0.7 $\pm$ 0.7	48.6 $\pm$ 5	23.3 $\pm$ 11.3	11523.3 $\pm$ 16911	3.4 $\pm$ 2.7
37-41	32.7 $\pm$ 19	33.2 $\pm$ 25.2	1 $\pm$ 1.3	43.5 $\pm$ 11.6	24.3 $\pm$ 9.6	1764.7 $\pm$ 1756.4	2.4 $\pm$ 0.7
42-46	169.2 $\pm$ 55	229.2 $\pm$ 77	5 $\pm$ 3.3	51.4 $\pm$ 3.6	26.7 $\pm$ 9.5	72389.4 $\pm$ 54059	4 $\pm$ 1.8
47-51	55.2 $\pm$ 59.7	64.1 $\pm$ 85.2	1.4 $\pm$ 1.3	44.4 $\pm$ 3.7	21.6 $\pm$ 11.8	29692.3 $\pm$ 64251	4 $\pm$ 1.5
52-56	50 $\pm$ 56.6	56.2 $\pm$ 86	0.3 $\pm$ 0.4	58.3 $\pm$ 11.8	22.4 $\pm$ 4	170756 $\pm$ 37064	3.3 $\pm$ 0.9
57-61	31 $\pm$ 5.2	7.3 $\pm$ 11.8	0.6 $\pm$ 0.5	54.6 $\pm$ 12.2	29.9 $\pm$ 7.3	50.1 $\pm$ 502.6	3.5 $\pm$ 1.9
62-66	36.9 $\pm$ 16.7	34.3 $\pm$ 21.1	1.4 $\pm$ 1.2	51 $\pm$ 6.5	24.8 $\pm$ 5.3	1180 $\pm$ 703.3	3.5 $\pm$ 1.1
67-71	27.1 $\pm$ 2.9	18.8 $\pm$ 1.2	0.6 $\pm$ 0.9	59.9 $\pm$ 11.4	24.2 $\pm$ 9.4	615 $\pm$ 404.3	4 $\pm$ 1.1
72-76	40.7 $\pm$ 29	37.1 $\pm$ 29	1.2 $\pm$ 0.9	60.1 $\pm$ 16.4	26.8 $\pm$ 7.5	4935.7 $\pm$ 9552.1	3.2 $\pm$ 1.2

Drivers' heart rate variability (HRV) indicators per 5 minutes on the speed limit section in Table 3 to know: when the heart rate variability in different time domain and frequency domain indexes are changed. In the 2min-6min time period SDNN, RMSSD, PNN50, LFnorm, TP are high and volatile, HFnorm is lower. This phenomenon reveals that in the initial stage of the experiment, the driver is not suit the equipment and test sections, resulting in driver with a little tension to sympathetic increased. Drivers traveling at the speed limit section of 7-26min are stable driving stage that the heart rate variability index value has a little change. In Continued driving time for 27min-31min, driver's SDNN, RMSSD, TP values and volatility are significantly higher than the initial phase of experimental values within 2-6min. During times of 27min-31min, HRV of driver has physiological mutations, which roughly is the same trend and same time of driver's heart rate, combined with the results of

the subjective questionnaire section of the driver is indeed a mutation of driver's feeling for irritability, fatigue. This Phenomenon shows that the driver heart rate, heart rate variability index and the drivers' survey are consistency of psychological and physiological changes on the test road. driving with the. During the 32min-41min period, the value of heart rate variability is stable. In the driver's driving time to the 42min-46min, SDNN, RMSSD, PNN50, LFnorm, TP, LF / HF values are higher than 27-31min. Combined with experimental records, it shows that in this time period driver driving a vehicle to reach the toll station. It indicates that heart rate variability can report the influence of external environment to the driver's Physiological responses. And the sensitivity of heart rate variability is greater than the heart rate of growth.

4 Conclusions

The results show that:

(1) The driver is negatively correlated with the driving time heart rate, and the driver's growth rate of heart rate appears negative growth with driving time increasing.

(2) The growth of driver's heart rate and heart rate variability (HRV) can reflect fatigue.

(3) And heart rate variability (HRV) is more sensitive than the heart rate of growth to driver's fatigue when driving.

(4) Recommendation: In prairie highway landscape environment, we can have a further research about Fatigue threshold value of growth of driver's heart rate and heart rate variability (HRV).

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